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Doi

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(54) **ELECTRICAL CONNECTOR**

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(Continued)

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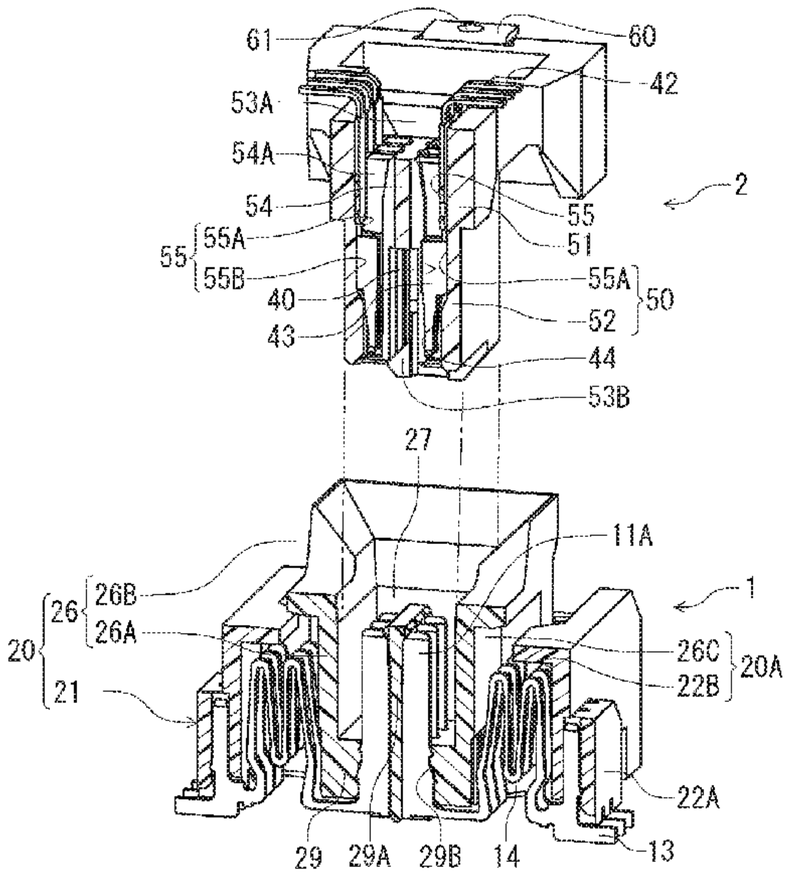
(57) **ABSTRACT**

An electrical connector includes a terminal having a connecting portion to be connected to an electrical circuit board and a contact portion to be contacted with a mating connector; and a housing for holding the terminal. The housing includes a fixed housing and a movable housing arranged to be movable relative to the fixed housing. The terminal includes a fixed side held portion held with the fixed housing, a movable side held portion held with the movable housing, and an elastic portion situated between the fixed side held portion and the movable side held portion. The housing includes an accommodating space for accommodating the elastic portion. The elastic portion includes a first wave shape portion having a first bent portion and a pair of first extending portions. The first extending portions are configured to extend away from each other with a distance in between decreasing toward the first bent portion.

5 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

H01R 12/70	(2011.01)
H01R 13/631	(2006.01)
H01R 13/502	(2006.01)
H01R 12/71	(2011.01)

(52) **U.S. Cl.**
CPC ***H01R 13/6315*** (2013.01); *H01R 12/707* (2013.01); *H01R 12/712* (2013.01)

(58) **Field of Classification Search**
USPC 439/248, 81, 247, 74
See application file for complete search history.

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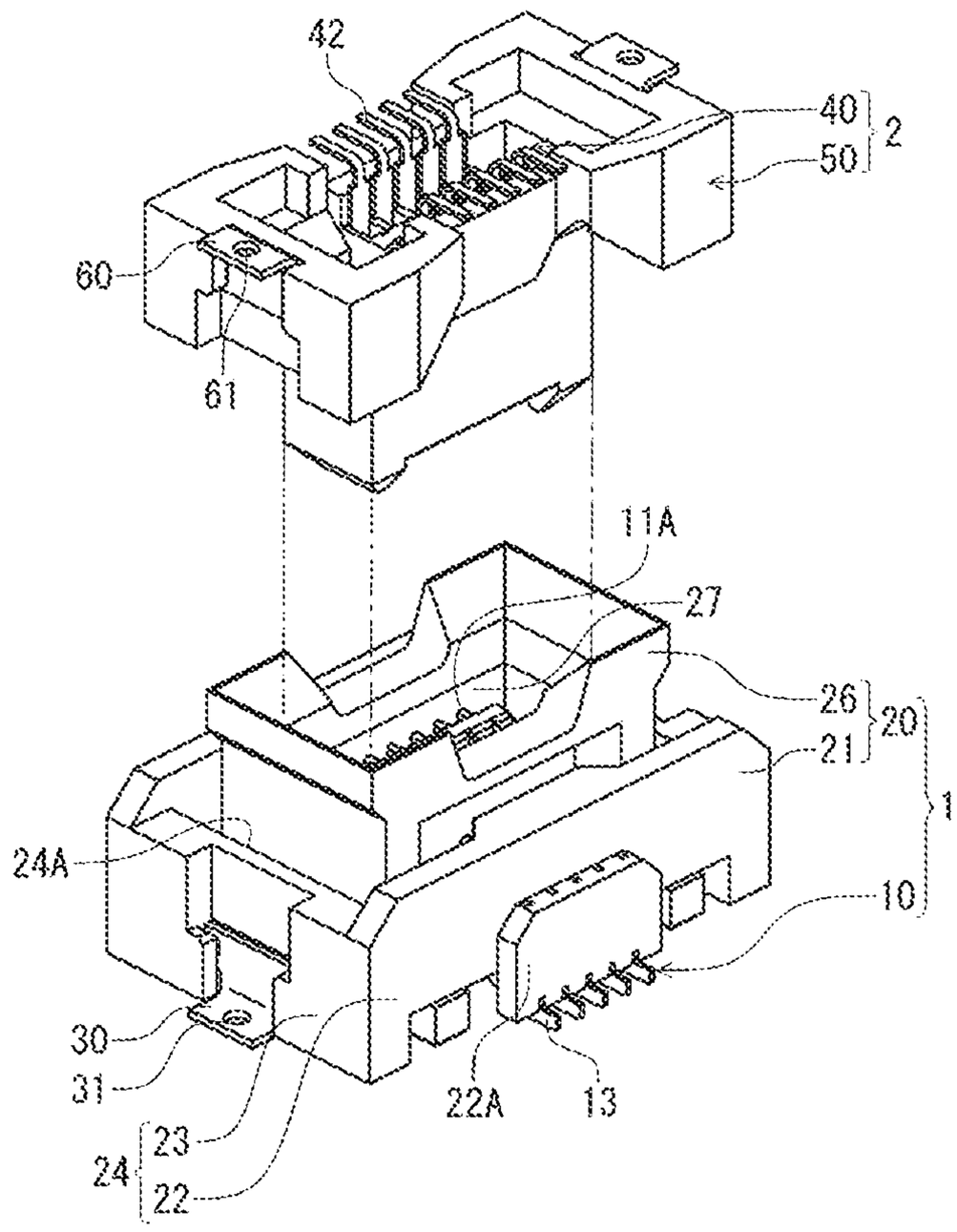


FIG. 1 (A)

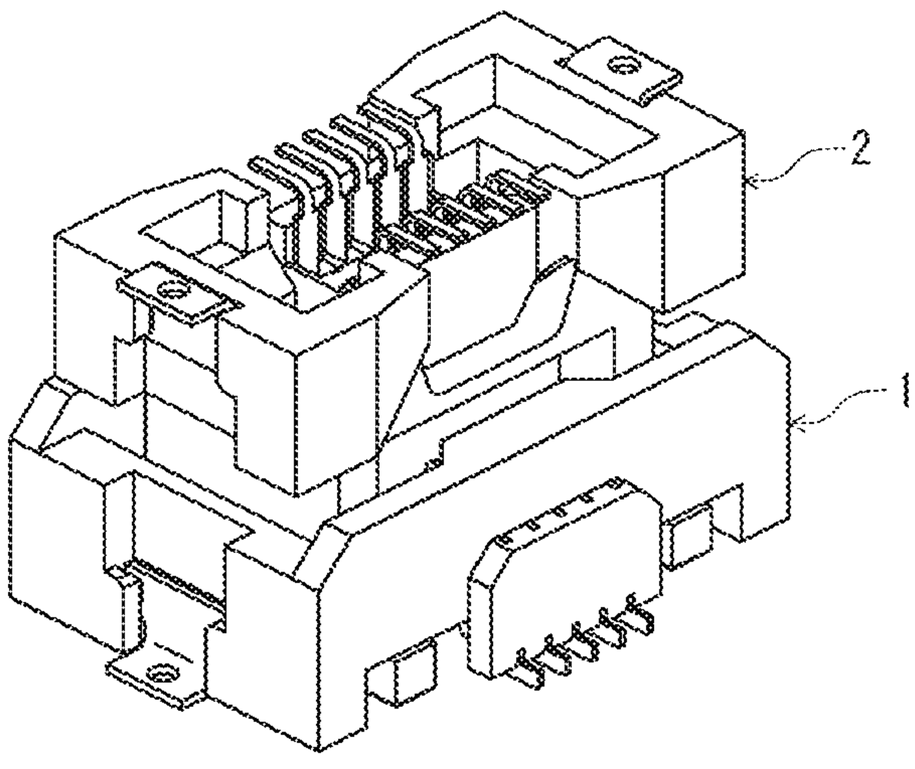
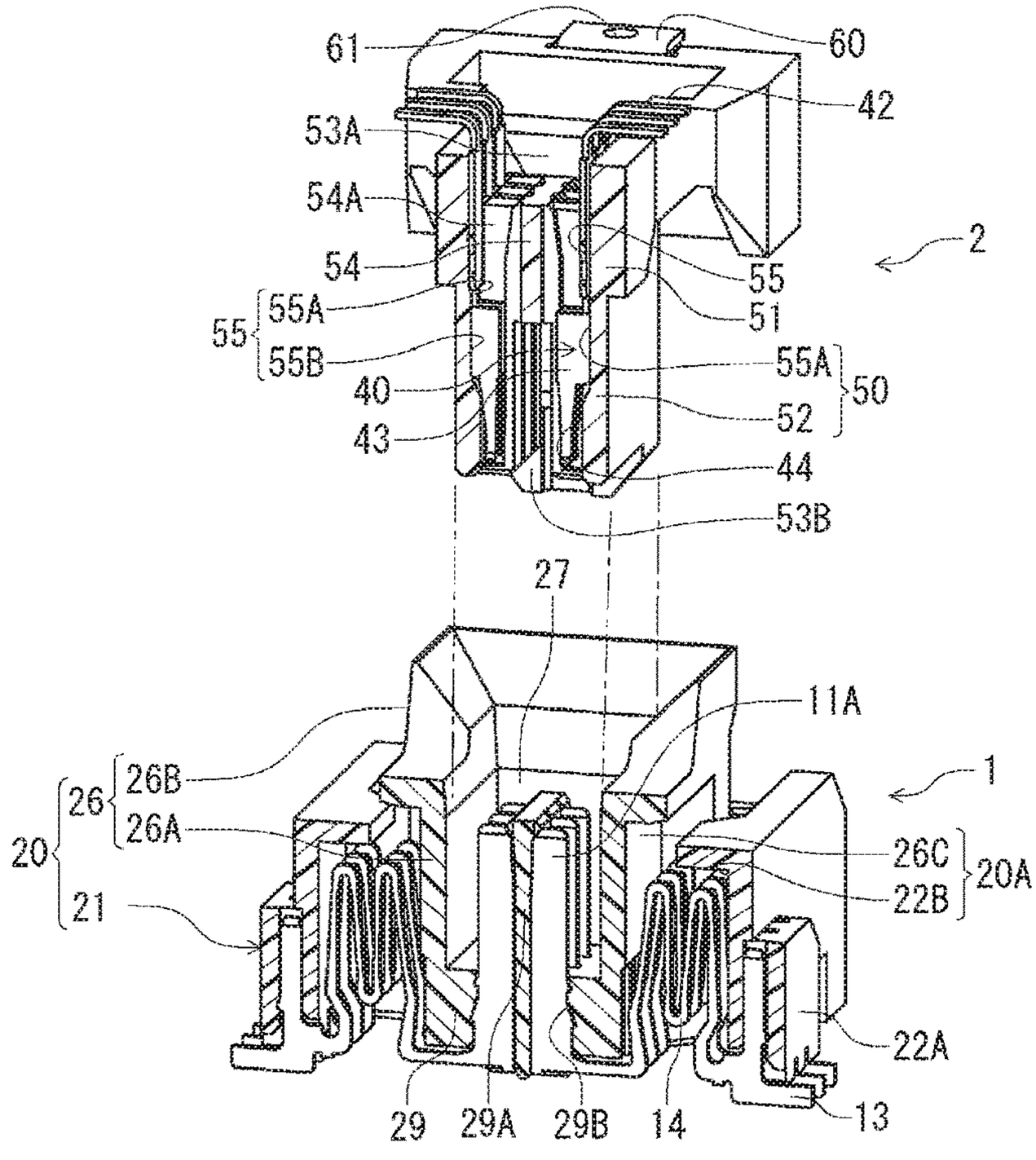


FIG. 1 (B)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53B
27
11A
1
26
26B
26A
20
26C
20A
22B
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22A
29
29A
29B
14
13

FIG. 2 (A)

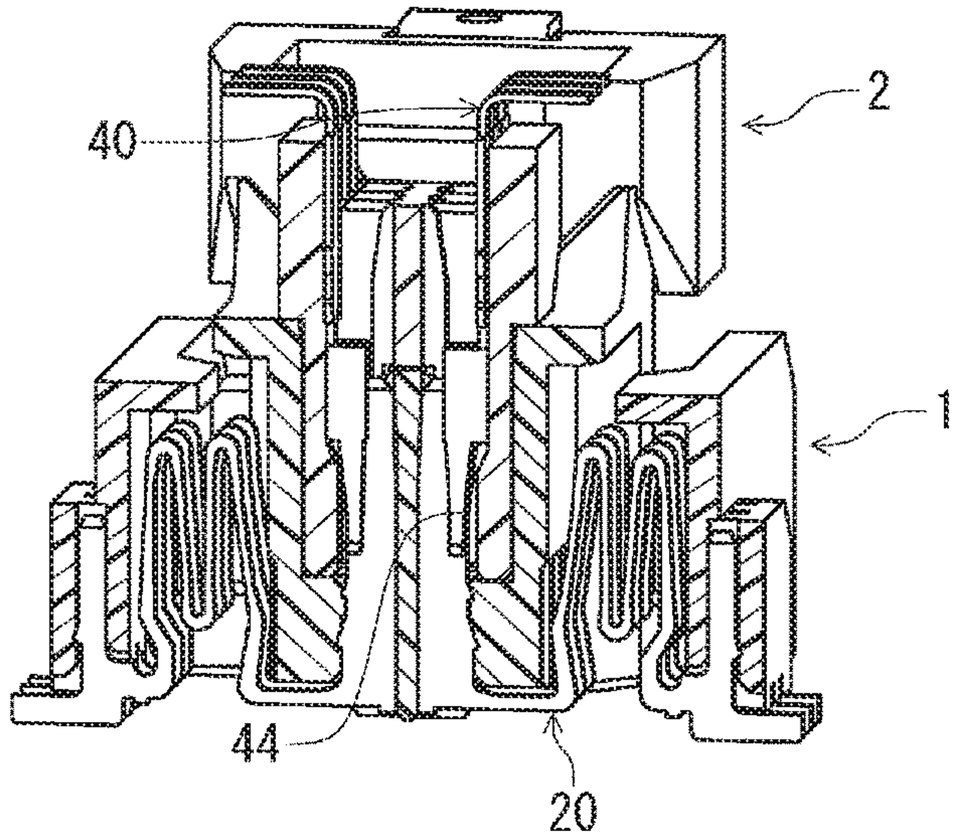
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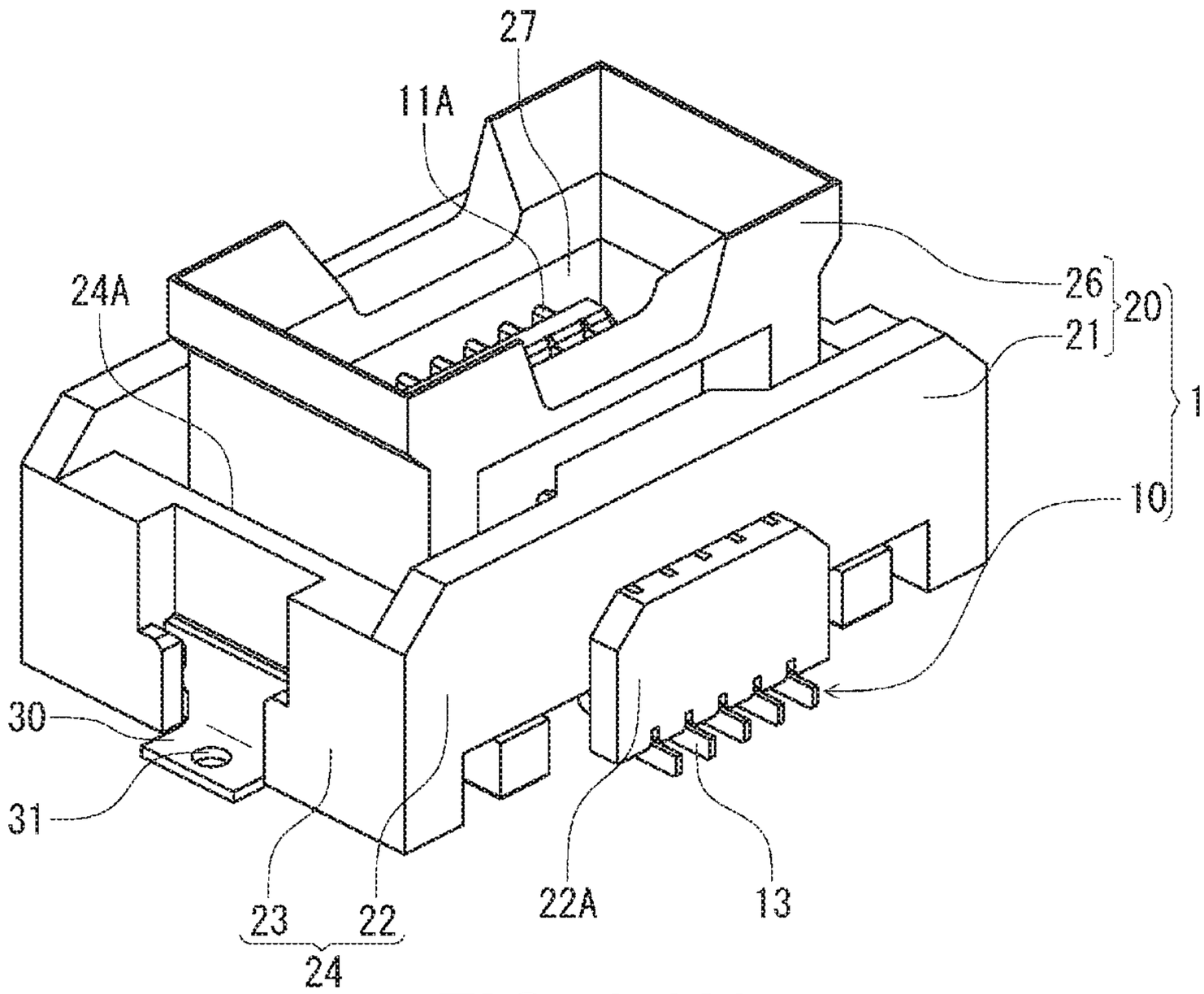
FIG. 2 (B)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22A
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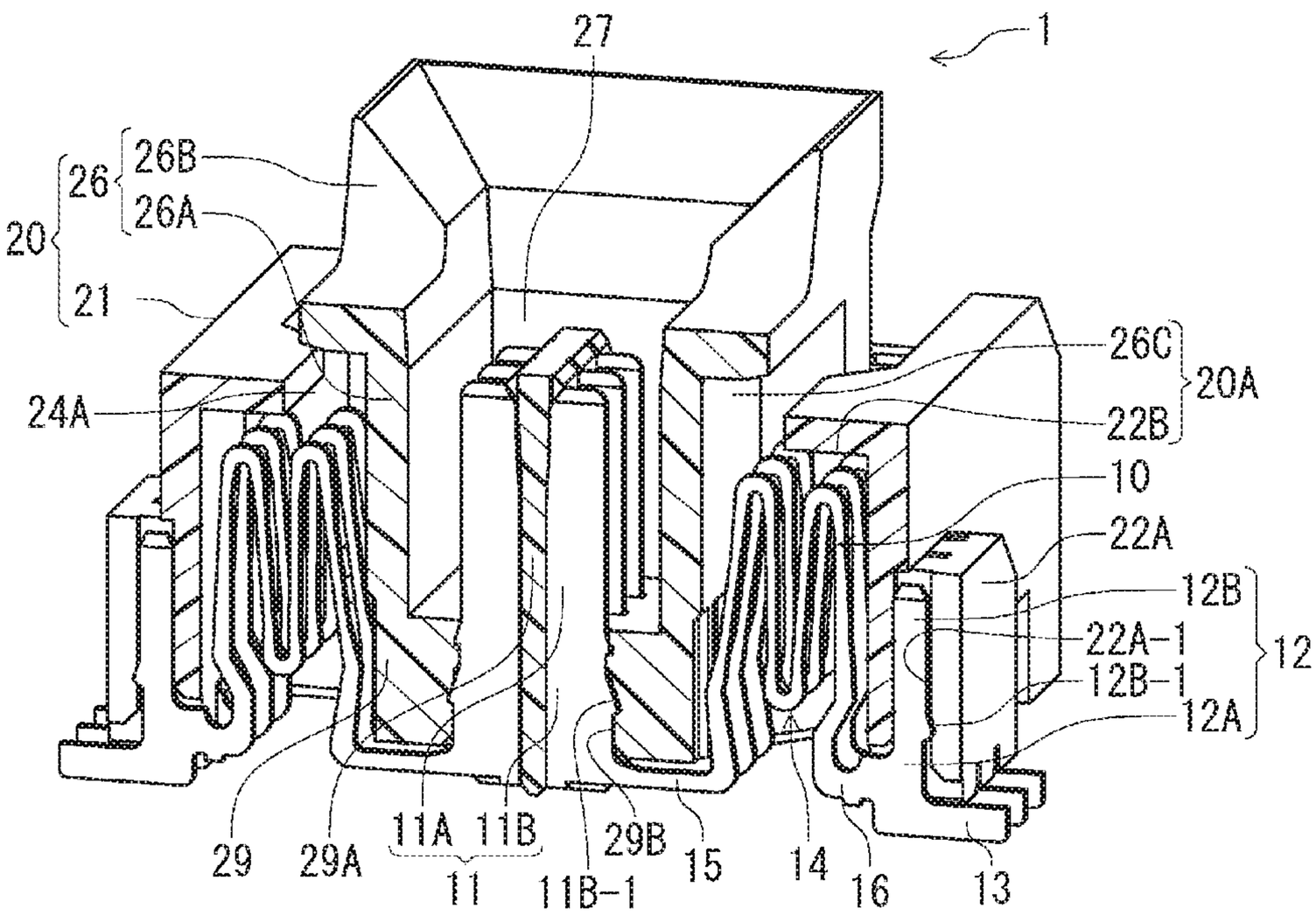
FIG. 3 (A)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26B
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26C
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11B-1
29B
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16
13

FIG. 3 (B)

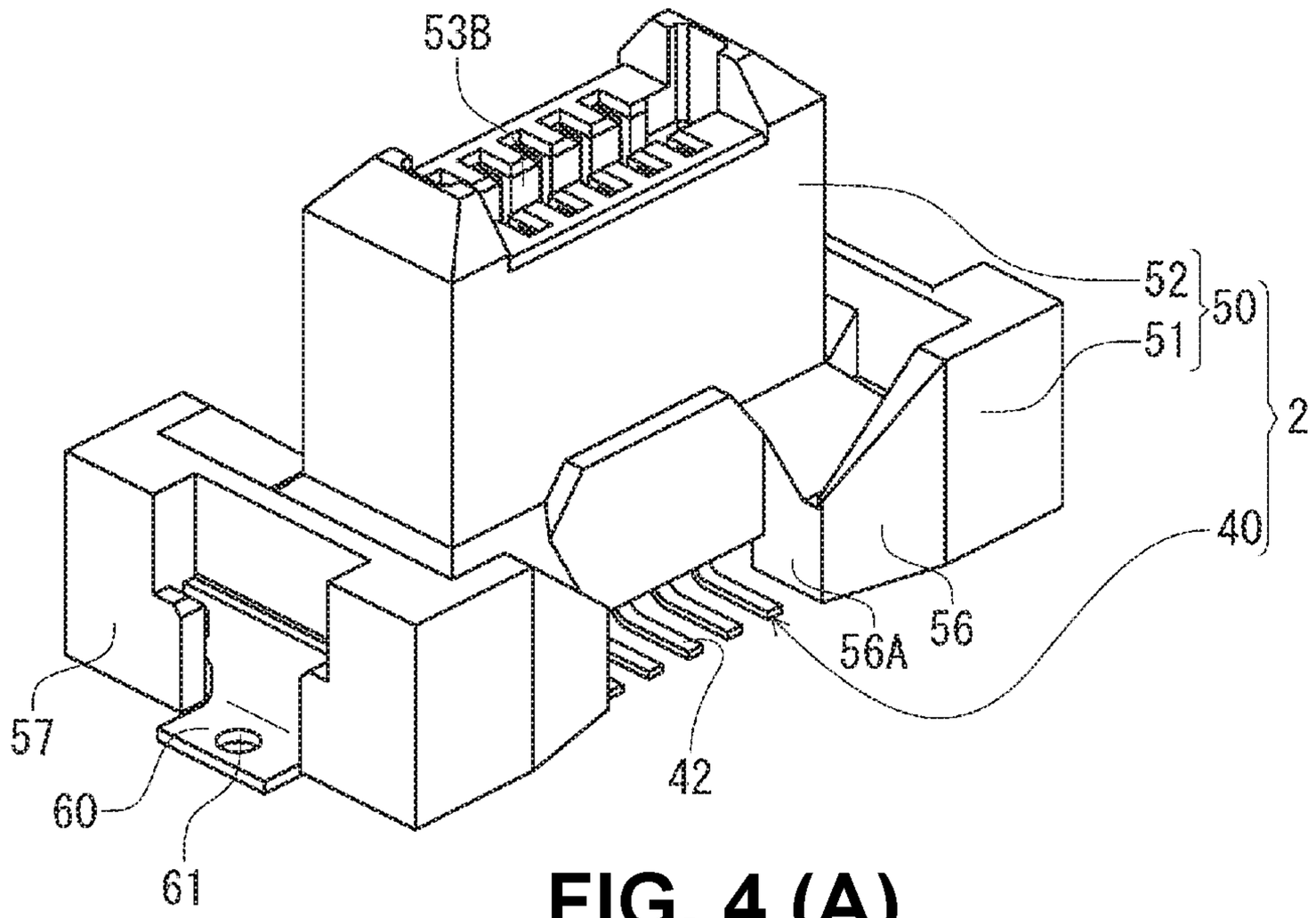
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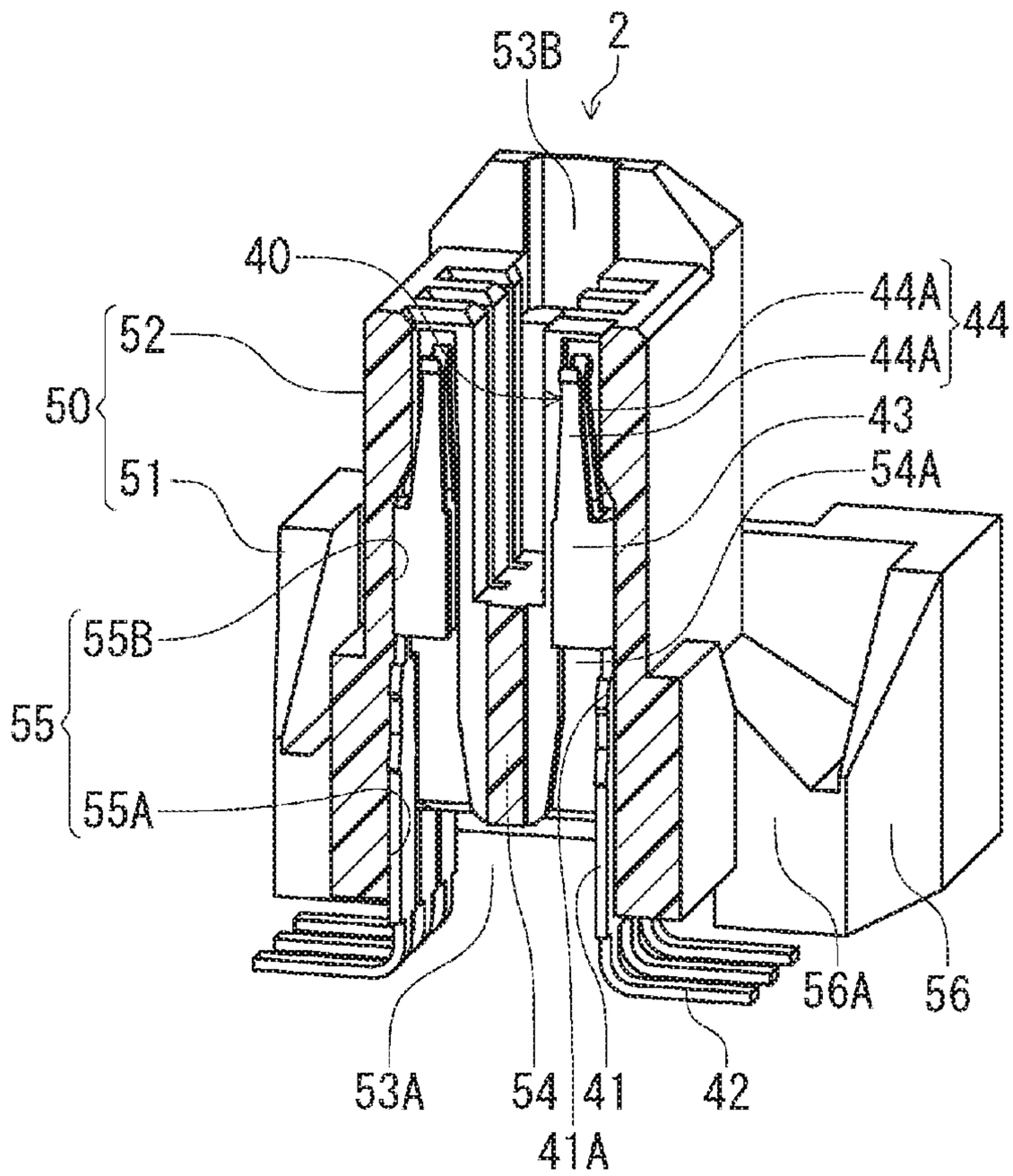
FIG. 4 (A)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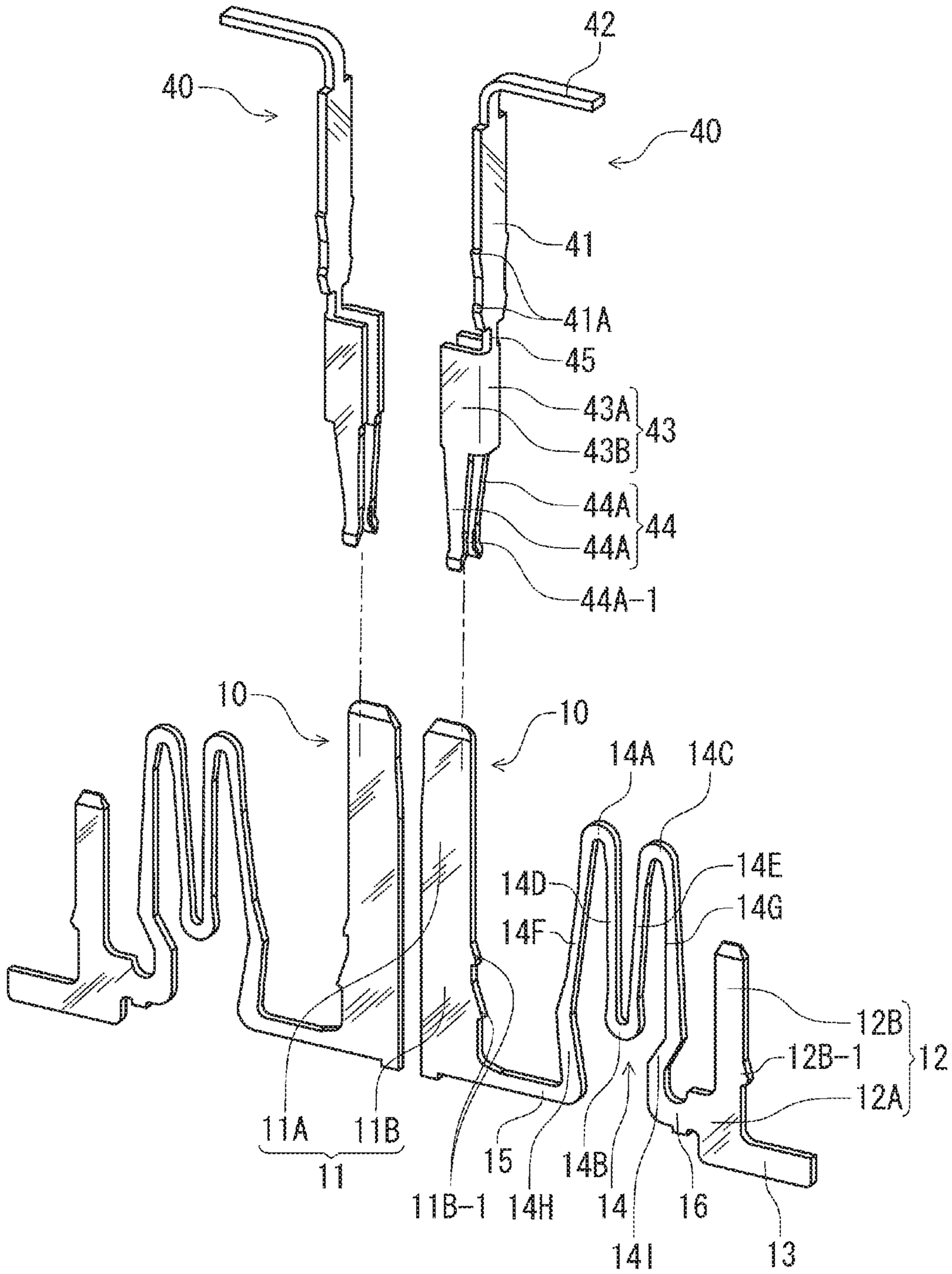
41A

FIG. 4 (B)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14G
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11B
11
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14B
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14H
14
16
14I
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FIG. 5

ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION AND RELATED ART STATEMENT

The present invention relates to an electrical connector to be attached to an electrical circuit board for connecting a mating connecting member to the electrical circuit board in a direction perpendicular to a surface of the electrical circuit board.

Patent Reference has disclosed a conventional electrical connector for connecting an electrical circuit board. The conventional electrical connector includes a housing. The housing includes a fixed housing to be fixed to the electrical circuit board and a movable housing capable of moving relative to the fixed housing. The conventional electrical connector further includes a terminal disposed between the fixed housing and the movable housing.

Patent Reference: Japanese Patent Publication No. 2014-099361

In the conventional electrical connector disclosed in Patent Reference, the fixed housing to be fixed to the electrical circuit board is formed in a rectangular frame shape, so that a central portion at a center of the rectangular frame shape is opened and penetrates through a vertical direction of the fixed housing. The movable housing is accommodated in the central portion of the fixed housing such that a space is created between the fixed housing and the movable housing around a circumference of the movable housing. The movable housing includes a hollow portion that is opened upwardly, so that a mating connector as a mating connecting member is fitted in the hollow portion from above.

In the conventional electrical connector, the terminal includes an elastic piece portion on one end portion thereof. The elastic piece portion has a contact portion to be contacted with and connected to the mating connector, and is situated in the hollow portion of the movable housing. Further, the terminal includes a board connecting portion on the other end portion thereof. The board connecting portion protrudes outside the fixed housing.

In the conventional electrical connector, the elastic piece portion of the terminal disposed at the one end portion of the terminal extends to a bottom portion of the movable housing, and an arm portion is provided a lower end portion of the elastic piece portion. The arm portion extends outside the movable housing. A fixed piece portion is formed at a middle position of the arm portion, and the fixed piece portion is fitted in and fixed to a hole portion of the movable housing.

In the conventional electrical connector, the board connecting portion of the terminal disposed at the other end portion of the terminal is connected to the arm portion situated at a bottom portion of the fixed housing. A fixed piece portion is formed at a middle position of the arm portion, and the fixed piece portion is fitted in and fixed to a hole portion of the fixed housing.

In the conventional electrical connector, the terminal further includes a movable portion disposed between the arm portion on the movable housing side and the arm portion on the fixed housing side. The movable portion is formed of an open loop shape rising from a position of the bottom portion, so that the movable portion is capable of deforming. The movable portion includes a base portion connected to the arm portion on the movable housing side and the arm portion on the fixed housing side.

In the conventional electrical connector, the movable portion with the open loop shape is disposed such that the base portion thereof is situated close to that of the adjacent

movable portion, so that the movable portion is capable of deforming to a large extent. Accordingly, the movable portion is formed in a substantially circular shape as a whole. Further, the movable portion is situated in the space between the fixed housing and the movable housing. When the movable portion is elastically deformed, the movable housing is capable of moving in any direction of an orthogonal coordinate axis in the space, thereby achieving a floating effect.

In general, the conventional electrical connector is required to have a small height size from the surface of the electrical circuit board. At the same time, the conventional electrical connector is preferably capable of floating in any direction.

In the conventional electrical connector disclosed in Patent Reference, the terminal has the movable portion having the substantially loop shape, so that the movable portion is capable of deforming to a large extent. When the conventional electrical connector is configured to increase a floating amount in the height direction thereof (the direction perpendicular to the plate surface of the electrical circuit board) or the width direction thereof (the direction in parallel to the plate surface of the electrical circuit board), it is necessary to increase the size of the movable portion in the height direction or the width direction. As a result, it is necessary to increase the size of the conventional electrical connector in the height direction or the width direction thereof.

In view of the above problems, an object of the present invention is to provide an electrical connecting member capable of solving the problems of the conventional electrical connector. According to the present invention, it is possible to secure the floating amount of the electrical connector in the height direction and the width direction of the electrical connector without increasing the size of the electrical connector in the height direction thereof.

Further objects and advantages of the present invention will be apparent from the following description of the present invention.

SUMMARY OF THE INVENTION

In order to solve the problems described above, according to a first aspect of the present invention, an electrical connector is provided for connecting an electrical circuit board to a mating connecting member. The electrical connector includes a terminal and a housing for holding the terminal. The terminal has a connecting portion to be connected to the electrical circuit board and a contact portion to be contacted with the mating connecting member. The housing includes a fixed housing to be attached to the electrical circuit board and a movable housing arranged to be movable relative to the fixed housing, so that the mating connecting member is fitted in the movable housing.

According to the first aspect of the present invention, the terminal includes a fixed side held portion held with the fixed housing, a movable side held portion held with the movable housing, and an elastic portion connecting between the fixed side held portion and the movable side held portion. The elastic portion is configured to be capable of elastically deforming. The housing includes an accommodating space situated between the fixed housing and the movable housing for accommodating the elastic portion. The elastic portion includes a plurality of wave shape portions formed in one continuous band shape portion. The wave shape portion has a plurality of bent portions repeatedly bending continuously in bend directions. Each of the wave shape portions situated adjacent to the fixed side held

portion and the movable side held portion has an enlarging width portion, in which an opening width of a wave shape increases away from the bent portions.

According to the first aspect of the present invention, when the terminal receives an external force, the elastic portion of the terminal is elastically deformed. Accordingly, the movable housing is moved relative to the fixed housing by an elastic deformation amount of the elastic portion. As a result, it is possible to achieve floating of the electrical connector.

According to the first aspect of the present invention, the elastic portion includes the wave shape portions formed in one continuous band shape portion. The wave shape portion has the bent portions repeatedly bending continuously in bend directions. Accordingly, even when the elastic portion does not have a large size in the height direction thereof, it is possible to sufficiently secure the elastic deformation amount. As a result, it is possible to minimize a size of the connector in the height direction thereof.

According to the first aspect of the present invention, the wave shape portions situated adjacent to the fixed side held portion and the movable side held portion have the enlarging width portions. Accordingly, when the wave portions are elastically deformed in the width direction thereof, and the wave shape portions situated adjacent to the fixed side held portion and the movable side held portion approach closer to each other at base portions thereof, the wave shape portions do not contact with each other. Accordingly, it is possible to prevent the terminal from being damaged. Further, it is possible to secure a sufficient floating amount.

According to a second aspect of the present invention, an electrical connector is provided for connecting an electrical circuit board to a mating connecting member. The electrical connector includes a terminal and a housing for holding the terminal. The terminal has a connecting portion to be connected to the electrical circuit board and a contact portion to be contacted with the mating connecting member. The housing includes a fixed housing to be attached to the electrical circuit board and a movable housing arranged to be movable relative to the fixed housing, so that the mating connecting member is fitted in the movable housing.

According to the second aspect of the present invention, the terminal includes a fixed side held portion held with the fixed housing, a movable side held portion held with the movable housing, and an elastic portion connecting between the fixed side held portion and the movable side held portion. The elastic portion is configured to be capable of elastically deforming. The housing includes an accommodating space situated between the fixed housing and the movable housing for accommodating the elastic portion. The elastic portion includes a plurality of wave shape portions formed in one continuous band shape portion.

According to the second aspect of the present invention, the terminal further includes a fixed side transition portion extending from the elastic portion to the fixed side held portion and a movable side transition portion extending from the elastic portion to the movable side held portion. The fixed side transition portion and the movable side transition portion are situated outside a range of the wave shape portions in a height direction of the wave shape portions.

According to the second aspect of the present invention, similar to the first aspect, when the terminal receives an external force, the elastic portion of the terminal is elastically deformed. Accordingly, the movable housing is moved relative to the fixed housing by an elastic deformation amount of the elastic portion. As a result, it is possible to achieve floating of the electrical connector.

According to the second aspect of the present invention, similar to the first aspect, the elastic portion includes the wave shape portions formed in one continuous band shape portion. The wave shape portion has the bent portions repeatedly bending continuously in bend directions. Accordingly, even when the elastic portion does not have a large size in the height direction thereof, it is possible to sufficiently secure the elastic deformation amount.

According to the second aspect of the present invention, in addition to the first aspect, the fixed side transition portion and the movable side transition portion are situated outside the range of the wave shape portions in the height direction of the wave shape portions. Accordingly, it is possible to dispose the wave shape portions in a space opposite to the fixed side transition portion and the movable side transition portion in the height direction of the wave shape portions. As a result, it is possible to increase the height of the wave shape portions.

According to the second aspect of the present invention, the wave shape portions are not disposed between the fixed side transition portion and the movable side transition portion in a direction connecting between the fixed side transition portion and the movable side transition portion (the width direction of the wave shape portions). Accordingly, even when the wave portions are elastically deformed in the width direction thereof, the fixed side transition portion does not contact with the movable side transition portion.

According to the second aspect of the present invention, the wave shape portions are formed in the shape repeatedly bent in the vertical direction. Further, when one of the wave shape portions situated at the middle is situated at a position slightly higher than that of the bottom portion, it is possible to dispose the fixed side transition portion closer to the movable side transition portion. Accordingly, it is possible to minimize the side of the electrical connector in the connector width direction.

According to a third aspect of the present invention, each of the wave shape portions of the terminal may be formed to have an extending portion between the bent portions situated adjacent to each other. Accordingly, the elastic portion is capable of deforming with the bent portion as a pivot, so that the elastic portion is capable of elastically deforming as a whole. Further, when a length of the extending portion is increased, it is possible to increase the elastic deformation amount of the elastic portion.

According to a fourth aspect of the present invention, each of the wave shape portions of the terminal may be formed to have the bent portion formed in a band shape bent within a plate surface thereof. Further, the terminal may be formed to have the extending portion having a width smaller than that of the bent portion. Accordingly, when the elastic portion is elastically deformed with the bent portion as the pivot, the extending portion tends not to contact with the adjacent extending portion.

According to the present invention, it should be noted that the mating connecting member may include an electrical connector or an electrical circuit board.

As described above, according to the first aspect and the second aspect of the present invention, the fixed housing and the movable housing hold the terminal. The terminal includes the elastic portion accommodated in the space created between the fixed housing and the movable housing. The elastic portion includes the wave shape portions formed in one continuous band shape portion. The wave shape portion has the bent portions repeatedly bending continuously in bend directions. Accordingly, even when the elastic portion does not have a large size in the height direction

thereof, it is possible to sufficiently secure the elastic deformation amount. As a result, it is possible to minimize a size of the connector in the height direction thereof.

Further, according to the first aspect of the present invention, each of the wave shape portions situated adjacent to the fixed side held portion and the movable side held portion has the enlarging width portion, in which the opening width of the wave shape increases away from the bent portions. Accordingly, when the wave portions are elastically deformed in the width direction thereof, and the wave shape portions situated adjacent to the fixed side held portion and the movable side held portion approach closer to each other at base portions thereof, the wave shape portions do not contact with each other. Accordingly, it is possible to prevent the terminal from being damaged. Further, it is possible to secure a sufficient floating amount.

Further, according to the second aspect of the present invention, the wave shape portions are not disposed between the fixed side transition portion and the movable side transition portion in the direction connecting between the fixed side transition portion and the movable side transition portion (the width direction of the wave shape portions). Accordingly, even when the wave portions are elastically deformed in the width direction thereof, the fixed side transition portion does not contact with the movable side transition portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**(A) and **1**(B) are perspective views showing an electrical connector assembled member including a plug side connector (a first connector) and a receptacle side connector (a second connector) to be connected to the plug side connector according to an embodiment of the present invention, wherein FIG. **1**(A) is a perspective view showing the electrical connector assembled member before the first connector is connected to the second connector and FIG. **1**(B) is a perspective view showing the electrical connector assembled member after the first connector is connected to the second connector;

FIGS. **2**(A) and **2**(B) are sectional views showing the electrical connector assembled member according to the embodiment of the present invention, wherein FIG. **2**(A) is a sectional view showing the electrical connector assembled member before the first connector is connected to the second connector and FIG. **2**(B) is a sectional view showing the electrical connector assembled member after the first connector is connected to the second connector;

FIGS. **3**(A) and **3**(B) are views showing the first connector according to the embodiment of the present invention, wherein FIG. **3**(A) is a perspective view showing the first connector and FIG. **3**(B) is a sectional view showing the first connector;

FIGS. **4**(A) and **4**(B) are views showing the second connector according to the embodiment of the present invention, wherein FIG. **4**(A) is a perspective view showing the second connector and FIG. **4**(B) is a sectional view showing the second connector; and

FIG. **5** is a perspective view showing a first terminal of the first connector and a second terminal of the second connector according to the embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereunder, embodiments of the present invention will be described with reference to the accompanying drawings.

An embodiment of the present invention will be explained. FIGS. **1**(A) and **1**(B) are perspective views showing an electrical connector assembled member including a plug side connector (a first connector **1**) and a receptacle side connector (a second connector **2**) to be connected to the plug side connector according to an embodiment of the present invention. More specifically, FIG. **1**(A) is a perspective view showing the electrical connector assembled member before the first connector **1** is connected to the second connector **2**, and FIG. **1**(B) is a perspective view showing the electrical connector assembled member after the first connector **1** is connected to the second connector **2**.

FIGS. **2**(A) and **2**(B) are sectional views showing the electrical connector assembled member according to the embodiment of the present invention. More specifically, FIG. **2**(A) is a sectional view showing the electrical connector assembled member before the first connector **1** is connected to the second connector **2**, and FIG. **2**(B) is a sectional view showing the electrical connector assembled member after the first connector **1** is connected to the second connector **2**.

FIGS. **3**(A) and **3**(B) are views showing the first connector **1** according to the embodiment of the present invention. More specifically, wherein FIG. **3**(A) is a perspective view showing the first connector **1** and FIG. **3**(B) is a sectional view showing the first connector **1**. FIGS. **4**(A) and **4**(B) are views showing the second connector **2** according to the embodiment of the present invention. More specifically, FIG. **4**(A) is a perspective view showing the second connector **2**, and FIG. **4**(B) is a sectional view showing the second connector **2**.

As shown in FIG. **1**(A), the first connector **1** includes first terminals **10** with a male type and a first housing **20** formed of an electrically insulation material for holding the first terminals **10**. It should be noted that the terminal and the housing of the first connector **1** are designated with "first", and the terminal and the housing of the second connector **2** are designated with "second". Further, the first housing **20** includes a fixed housing **21** and a movable housing **26**. The fixed housing **21** is to be attached to an electrical circuit board (not shown) through the first terminals **10**. The movable housing **26** is configured to be movable relative to the fixed housing **21**.

In the embodiment, the first housing **20** of the first connector **1** is formed in a substantially cuboid shape extending in a longitudinal direction and a lateral direction along a plane in parallel to the electrical circuit board. The first terminals **10** are arranged in two rows along the longitudinal direction of the first housing **20**. More specifically, the first terminals **10** are arranged in two rows to face each other symmetrically in the lateral direction (a width direction of the first connector **1**) perpendicular to the longitudinal direction.

As shown in FIG. **1**(A), the fixed housing **21** includes a circumferential wall **24** formed of a side wall **22** and an edge wall **23**. The side wall **22** is formed to rise perpendicularly relative to the electrical circuit board and extend in the longitudinal direction. The edge wall **23** is formed to extend in the lateral direction. A central space **24**A is formed inside the circumferential wall **24** to penetrate in a vertical direction, so that the central space **24**A accommodates the movable housing **26** from above.

In the embodiment, the side wall **22** extends over a terminal arrangement range where the first terminals **10** are arranged in the longitudinal direction. A protruding wall **22**A is formed on an outer wall surface of the side wall **22**,

so that the protruding wall **22**A holds the first terminals **10**. A fixed side recess portion **22**B is formed in an inner wall surface of the side wall **22**, so that the fixed side recess portion **22**B opens inwardly and downwardly. It should be noted that the fixed side recess portion **22**B forms a part of an accommodation space **20**A for accommodating an elastic portion of the first terminal **10** (described later). Further, the protruding wall **22**A and the fixed side recess portion **22**B will be described in more detail later relative to the first terminals **10**.

In the embodiment, an attachment metal member **30** with an L character shape is attached to the edge wall **23** of the fixed housing **21** on an outer surface thereof, so that the fixed housing **21** is securely fixed to the electrical circuit board through an attachment hole **31** formed in the attachment metal member **30** with solder. It should be noted that it is not necessary to provide the attachment metal member **30** for attaching the fixed housing **21** to the electrical circuit board. Alternatively, when the first terminals **10** can be securely attached to the electrical circuit board with solder, it is not necessary to provide the attachment metal member **30**.

In the embodiment, the movable housing **26** includes a penetrating portion **26**A and a protruding portion **26**B. The penetrating portion **26**A is arranged to penetrate into the central space **24**A of the fixed housing **21**. The protruding portion **26**B is arranged to protrude upwardly from the central space **24**A. Further, the movable housing **26** includes a receiving recess portion **27** disposed to open upwardly over a range from the protruding portion **26**B to the penetrating portion **26**A, so that the receiving recess portion **27** receives a mating connecting member, for example, the second connector **2** as a mating connector.

In the embodiment, a central protruding wall **29**A is disposed inside the receiving recess portion **27**. The central protruding wall **29**A is arranged to rise from a bottom wall **29** of the movable housing **26**, so that the central protruding wall **29**A holds the first terminals **10**. A movable side recess portion **26**C is formed in an outer surface of the penetrating portion **26**A of the movable housing **26**, so that the movable side recess portion **26**C opens downwardly to face the fixed side recess portion **21**B of the fixed housing **21**. It should be noted that the movable side recess portion **26**C and the fixed side recess portion **22**B form the accommodation space **20**A for accommodating the elastic portion of the first terminal **10** (described later).

FIG. **5** is a perspective view showing the first terminal **10** of the first connector **1** and a second terminal **40** of the second connector **2** according to the embodiment of the present invention.

As shown in FIG. **5**, the first terminal **10** as a male terminal is formed such that a flat surface of a metal plate is maintained. Further, the first terminals **10** are arranged in a pair to face with each other in a same direction, so that the first terminals **10** with the same shape become right-to-left symmetrical in the width direction of the first connector **1**. Further, the first terminals **10** are arranged in a plurality of pairs in the longitudinal direction of the first connector **1**.

As shown in FIG. **5**, among a plurality of pairs of the first terminals **10**, one pair of the first terminals **10** is taken out from the first housing **20**. Further, one pair of the second terminals **40** of the second connector **2**, which is to be connected to the first connector **1** as the mating connector, are shown in FIG. **5**. It should be noted that two of the first terminals **10** constituting the pair are arranged right-to-left symmetrically, and have an identical shape. In the following description, therefore, one of the first terminals **10** will be explained.

In the embodiment, the first terminal **10** includes a movable side column portion **11**; a fixed side column portion **12**; a connecting portion **13**; and an elastic portion **14**. The movable side column portion **11** is arranged to rise at a position close to the second terminal **40** as a mating member, so that the movable side column portion **11** faces the second terminal **40** in the width direction of the first connector **1**. Further, the movable housing **26** is configured to hold the movable side column portion **11**. The fixed side column portion **12** is arranged to rise at a position opposite to that of the movable side column portion **11** in the width direction of the first connector **1**. The connecting portion **13** is arranged to extend in the lateral direction from a lower end of the fixed side column portion **12**. The elastic portion **14** is disposed between the movable side column portion **11** and the fixed side column portion **12**.

In the embodiment, the movable side column portion **11** includes a contact portion **11**A at an upper half portion thereof and a movable side held portion **11**B at a lower half portion thereof. The contact portion **11**A is configured to contact with the second terminal **40**, which is a female type, of the second connector **2**. The movable side held portion **11**B is held with the movable housing **26**. The contact portion **11**A has a distal end portion (an upper end portion) that is chamfered, so that the movable side column portion **11** is easily inserted into the second terminal **40**. The movable side held portion **11**B has an engaging protrusion **11**B-**1** at a side edge thereof, so that the movable side column portion **11** can engage with the movable housing **26**.

In the embodiment, the movable side held portion **11**B is tightly fitted into a hold groove **29**B formed in the bottom wall **29** of the movable housing **26** from above, so that the hold groove **29**B holds the movable side held portion **11**B (refer to FIG. **3**(B)). When the movable side held portion **11**B is fitted into the hold groove **29**B, the engaging protrusion **11**B-**1** bites a corresponding inner surface of the hold grove **29**B, so that the engaging protrusion **11**B-**1** strongly engages with the hold grove **29**B.

In the embodiment, the fixed side column portion **12** includes a base portion **12**A at a lower end portion thereof and a fixed side held portion **12**B at an upper portion thereof above the base portion **12**A. The fixed side held portion **12**B has an engaging protrusion **12**B-**1**, so that the fixed side column portion **12** can engage with the fixed housing **21**. Further, the fixed side held portion **12**B is tightly fitted from below into a hold groove **22**A-**1** formed in the protruding wall **22**A that protrudes from the side wall **22** of the fixed housing **21** at a bottom wall surface thereof and penetrates in a vertical direction within a thickness of the protruding wall **22**A, so that the hold groove **22**A-**1** holds the fixed side held portion **12**B (refer to FIG. **3**(B)). When the fixed side held portion **12**B is fitted into the hold groove **22**A-**1**, the engaging protrusion **12**B-**1** bites a corresponding inner surface of the hold grove **22**A-**1**, so that the engaging protrusion **12**B-**1** strongly engages with the hold grove **22**A-**1**.

In the embodiment, the connecting portion **13** is arranged to extend from a lower end of the base portion **12**A of the fixed side column portion **12** in the lateral direction along a lower surface of the fixed housing **21**. Further, the connecting portion **13** is arranged to extend toward an outside of the fixed housing **21**.

In the embodiment, the first terminal **10** includes the elastic portion **14** at a position between the movable side held portion **11**B and the fixed side held portion **12**B. The elastic portion **14** is connected on the left side to the movable side held portion **11**B through a movable side transition portion **15** that extends from the lower end of the movable

side held portion **11**B in the lateral direction. Further, the elastic portion **14** is connected on the right side to the fixed side held portion **12**B through a fixed side transition portion **16** that extends from the base portion **12**A of the fixed side held portion **12**B in the lateral direction.

In the embodiment, the elastic portion **14** is configured to rise from the movable side transition portion **15** and the fixed side transition portion **16**, and is formed of a continuous band shape member bent in a substantially M character shape. Further, the elastic portion **14** with the substantially M character shape is formed in a band shape having a width smaller than that of the movable side held portion **11**B and the fixed side held portion **12**B.

More specifically, the elastic portion **14** includes two bent portions **14**A and **14**C having a curved shape at an upper portion thereof and a bent portion **14**B having a curved shape at a lower portion thereof. Further, the elastic portion **14** includes an inside straight portion **14**D connecting the bent portion **14**A and the bent portion **14**B and an inside straight portion **14**E connecting the bent portion **14**C and the bent portion **14**B. Further, the elastic portion **14** includes outside straight portions **14**F and **14**G extending outwardly from the bent portion **14**A and the bent portion **14**C, respectively.

As described above, in the embodiment, the elastic portion **14** is formed in the substantially M character shape, in which one wave shape portion with a substantially U character shape is disposed between two wave shape portions with a substantially U character shape. Accordingly, the elastic portion **14** is formed in a wave shape having three wave shapes arranged continuously, so that the elastic portion **14** is capable of elastically deforming. It should be noted that the three wave shape portions is formed of the bent portion and the straight portions. Further, in the three wave shape portions of the elastic portion **14**, the straight portions **14**D, **14**E, **14**F, and **14**G form widening width portions that are inclined such that an open width of the wave shape portions is increasing in a direction away from the bent portions **14**A, **14**C, and **14**B, respectively.

In the embodiment, among the three wave shape portions of the elastic portion **14**, the wave shape portion situated on the left side includes an inclined portion **14**H. The inclined portion **14**H is arranged to extend downwardly from the outside straight portion **14**F, and is inclined inwardly (the right side in FIG. **5**) and downwardly at a lower position below the bent portion **14**B in the vertical direction. Further, the wave shape portion situated on the right side includes an inclined portion **14**I. The inclined portion **14**I is arranged to extend downwardly from the outside straight portion **14**G, and is inclined inwardly (the left side in FIG. **5**) and downwardly at a lower position below the bent portion **14**B in the vertical direction.

As described above, in the elastic portion **14**, the inclined portion **14**H and the inclined portion **14**I are inclined inwardly and downwardly. Accordingly, a distance between the inclined portion **14**H and the inclined portion **14**I is reduced in a range below the bent portion **14**B situated at the lower portion of the elastic portion **14**.

In the embodiment, the elastic portion **14** is formed in the band shape with the small width, and is formed in the wave shape so that the elastic portion **14** is capable of elastically deforming. More specifically, in the elastic portion **14**, the straight portions **14**D, **14**E, **14**F, and **14**G have central portions having a terminal width (a band width) gradually decreasing and smaller than that of the bent portions **14**A and **14**C. Further, the straight portions **14**D and **14**E situated at the inside have the central portions having the terminal width (the band width) gradually decreasing and smaller than that of the bent portion **14**B. Further, the straight portions **14**F and **14**G situated at the outside have the central portions having the terminal width (the band width) gradually decreasing and smaller than that of the inclined portions **14**H and **14**I. It should be noted that the elastic portion **14** may have a portion having a width gradually decreasing at a position other than the central portion of the straight portions **14**D, **14**E, **14**F, and **14**G. With the portion having the width gradually decreasing, the elastic portion **14** is capable of easily and elastically deforming with the bent portion as a pivot.

As shown in FIGS. **1**(A) and **1**(B), FIGS. **2**(A) and **2**(B), and FIGS. **4**(A) and **4**(B), the second connector **2** includes the second terminals **40** with a female type and a second housing **50** formed of an electrically insulation material for holding the second terminals **40**. Further, the second housing **50** is attached to the electrical circuit board (not shown) through the second terminals **40**.

In the embodiment, the second housing **50** of the second connector **2** is formed in a substantially cuboid shape extending in a longitudinal direction thereof corresponding to the longitudinal direction of the first housing **20** of the first connector **1** and a lateral direction thereof corresponding to the lateral direction of the first housing **20** of the first connector **1**. The second terminals **40** are arranged in two rows along the longitudinal direction of the second housing **50**. More specifically, the second terminals **40** are arranged in two rows to face each other in the lateral direction (a width direction of the second connector **2**) perpendicular to the longitudinal direction. It should be noted that the second connector **2** is shown to face the first connector **1** in a fitting direction thereof in FIGS. **1**(A) and **2**(A). Further, the second connector **2** is shown in a posture turned over in the vertical direction in FIGS. **4**(A) and **4**(B).

In the embodiment, the second housing **50** of the second connector **2** that is the mating connector of the first connector **1** includes an attaching block portion **51** and a fitting block portion **52**. The attaching block portion **51** is to be attached to the electrical circuit board (not shown). The fitting block portion **52** is configured to protrude from the attaching block portion **51** in a fitting direction relative to the first connector **1**. Further, each of the attaching block portion **51** and the fitting block portion **52** is formed in a substantially cuboid shape extending in a longitudinal direction thereof corresponding to the longitudinal direction of the first connector **1** and a lateral direction thereof corresponding to the lateral direction of the first connector **1**.

In the embodiment, the second housing **50** includes an upper recess portion **53**A at an upper portion thereof and a lower recess portion **53**B at a lower portion thereof. The upper recess portion **53**A and the lower recess portion **53**B are situated at a center of the attaching block portion **51** viewed from above in FIGS. **1**(A)-**1**(B) and **2**(A)-**2**(B). Further, the lower recess portion **53**B has a width smaller than that of the upper recess portion **53**A, and a depth greater than that of the upper recess portion **53**A. Further, the second housing **50** includes a central wall portion **54** between the upper recess portion **53**A and the lower recess portion **53**B. Further, the second housing **50** includes a terminal groove **55**. The terminal groove **55** is arranged to extend along inner surfaces of the upper recess portion **53**A and the lower recess portion **53**B, and penetrate through the central wall portion **54**. The second terminal **40** is fitted into and held with the terminal groove **55** (described later).

In the embodiment, the second housing **50** further includes a side wall **56** extending in the longitudinal direc-

tion of the attaching block portion **51**, and a recess wall portion **56**A is formed in an outer surface of the side wall **56** at a central portion thereof in the longitudinal direction (refer to FIG. **4**(A)). The recess wall portion **56**A is recessed in the lateral direction. A connecting portion **42** of the second terminal **40** is accommodated in the recess wall portion **56**A, so that it is possible to easily connect the connecting portion **42** to the electrical circuit board and confirm that the connecting portion **42** is securely connected to the electrical circuit board.

In the embodiment, the second housing **50** further includes an edge wall **57** and an attachment metal member **60** with an L character shape attached to an outer surface of the edge wall **57**. The attachment metal member **60** has an attachment hole **61**, so that the second housing **50** is securely fixed to the electrical circuit board with solder. It should be noted that it is not necessary to provide the attachment metal member **60** for attaching the second housing **50** to the electrical circuit board. Alternatively, when the second terminals **40** can be securely attached to the electrical circuit board with solder, it is not necessary to provide the attachment metal member **60**.

As described above, FIG. **5** is the perspective view showing the first terminal **10** of the first connector **1** and the second terminal **40** of the second connector **2** before the first connector **1** is connected to the second connector **2** according to the embodiment of the present invention.

As shown in FIG. **5**, the second terminal **40** as a female terminal is formed of a metal plate member bent in a plate thickness direction. Further, similar to the first terminals **10**, the second terminals **40** are arranged in a pair to face with each other in a same direction, so that the second terminals **40** with the same shape become right-to-left symmetrical in the width direction of the second connector **2**. Further, the second terminals **40** are arranged in a plurality of pairs in the longitudinal direction of the second connector **2**.

As shown in FIG. **5**, among a plurality of pairs of the second terminals **40**, one pair of the second terminals **40** is taken out from the second housing **50**. It should be noted that two of the second terminals **40** constituting the pair are arranged right-to-left symmetrically, and have an identical shape. In the following description, therefore, one of the second terminals **40** will be explained.

In the embodiment, the second terminal **40** includes a held portion **41**; a connecting portion **42**; an intermediate base portion **43**; and a contact portion **44**. The held portion **41** is arranged at a middle portion of the second terminal **40**, and is formed in a flat band shape having a plate surface perpendicular to the plate surface of the first terminal **10**. The connecting portion **42** is arranged above the held portion **41**, and is bent perpendicular to the plate surface of the held portion **41**. The intermediate base portion **43** is arranged at the middle portion of the second terminal **40** and below the held portion **41**. Further, the intermediate base portion **43** has a cross section having a U character shape. The contact portion **44** is formed of a pair of contact pieces **44**A extending in a finger shape.

In the embodiment, the held portion **41** is formed in a flat plate shape. Further, the held portion **41** includes engaging protrusions **41**A for biting a corresponding surface of the terminal groove **55** of the second housing **50**.

In the embodiment, the second terminal **40** further includes a connecting portion **45** having a narrow width portion. The held portion **43** is connected to the held portion **41** through the connecting portion **45**. Further, the intermediate base portion **43** includes a bottom surface portion **43**A having a plate shape and a side surface portion **43**B. The bottom surface portion **43**A is configured to extend downwardly from the plate surface of the held portion **41**. The side surface portion **43**B is configured to extend from both side edges of the bottom surface portion **43**A, and has a plate surface perpendicular to a plate surface of the bottom surface portion **43**A. Accordingly, the intermediate base portion **43** is formed in a U character shape with the bottom surface portion **43**A and the side surface portion **43**B.

As described above, the contact portion **44** is formed of a pair of the contact pieces **44**A extending in a finger shape. The contact pieces **44**A are arranged to extend from lower ends of the side surface portion **43**B on both sides of the intermediate base portion **43**, so that the contact pieces **44**A face with each other. Further, the contact pieces **44**A are inclined downwardly in a direction such that a distance in between gradually decreases, so that the contact pieces **44**A become closer. Further, the distance between the contact pieces **44**A becomes a minimum near lower ends thereof, and the contact pieces **44**A expend at the lower ends thereof, so that a throat portion **44**A-**1** is formed at a location where the distance between the contact pieces **44**A becomes a minimum. The distance between the contact pieces **44**A at the throat portion **44**A-**1** is smaller than a plate thickness of the contact portion **11**A of the first terminal **10**, so that the contact pieces **44**A tightly sandwich and elastically contact with the contact portion **11**A at the throat portion **44**A-**1**.

With the configuration described above, the second terminals **40** are inserted into the terminal grooves **55** of the second housing **50** from above as shown in FIGS. **1**(A)-**1**(B) and **2**(A)-**2**(B). It should be noted that the second terminals **40** are inserted from blow in FIGS. **4**(A) and **4**(B), in which the second connector **2** is turned over vertically as opposed to that shown in FIGS. **1**(A)-**1**(B) and **2**(A)-**2**(B).

As shown in FIG. **2**(A), the terminal groove **55** includes a rectangular cylindrical hole portion **54**A formed in the central wall portion **54**. The rectangular cylindrical hole portion **54**A has an inner circumferential shape corresponding to an outer circumferential shape of the intermediate base portion **43** having the U character shape section, that is the maximum circumferential shape of the second terminal **40**. Further, the rectangular cylindrical hole portion **54**A is formed to penetrate the central wall portion **54** in the vertical direction, so that the intermediate base portion **43** is capable of passing through the rectangular cylindrical hole portion **54**A.

Further, the terminal groove **55** includes a groove portion **55**A formed in inner wall surfaces of the rectangular cylindrical hole portion **54**A and the upper recess portion **53**A. The groove portion **55**A has a groove depth corresponding to the plate thickness of the held portion **41**. Accordingly, after the intermediate base portion **43** with the U character shape section passes through the rectangular cylindrical hole portion **54**A of the central wall portion **54**, the groove portion **55**A accommodates the held portion **41** with the flat band shape situated at the inner wall surface of the upper recess portion **53**A. Further, when the engaging protrusion **41**A of the held portion **41** is tightly fitted into the groove portion **55**A of the terminal groove **55**, the engaging protrusion **41**A bites into an inner surface of the groove portion **55**A, so that the second housing **50** securely holds the second terminal **40** and prevents the second terminal **40** from coming off.

Further, the terminal groove **55** includes a groove portion **55**B formed in an inner wall surface of the lower recess portion **53**B below the central wall portion **54** (above in FIG. **4**(B). When the second terminal **40** is tightly fitted into the specific position, the groove portion **55**B accommodates the

intermediate base portion **43** and the contact portion **44**. The groove portion **55**B is arranged relative to the intermediate base portion **43** such that a groove bottom surface of the groove portion **55**B contacts with or is away from the bottom surface portion **43**A of the intermediate base portion **43**, and a groove side surface of the groove portion **55**B is away from the side surface portion **43**B of the intermediate base portion **43**. Further, the groove portion **55**B is arranged relative to the contact portion **44** to form a space in which the contact pieces **44**A are capable of elastically deforming.

A method of using the first connector **1** and the second connector **2** will be explained next. First, the first connector **1** and the second connector **2** are attached to the electrical circuit boards with solder, respectively. More specifically, the first connector **1** is attached to the electrical circuit board with the connecting portions **13** of the first terminals **10** and the attachment metal members **30**. Further, the second connector **2** is attached to the electrical circuit board with the connecting portions **42** of the second terminals **40** and the attachment metal members **60**. It should be noted that the electrical circuit boards are not shown in FIGS. **1**(A)-**1**(B) and **2**(A)-**2**(B). It should be noted that the first connector **1** is attached to the electrical circuit board at the lower surface thereof, and the second connector **2** is attached to the electrical circuit board at the upper surface thereof.

As shown in FIG. **1**(A) and FIG. **2**(A), in the next step, the second connector **2** attached to the electrical circuit board at the upper surface thereof is placed above the first connector **1**. It should be noted that at this moment, the fitting block portion **52** of the second connector **2** faces downwardly. Afterward, the second connector **2** is moved downwardly while maintaining the posture, so that the fitting block portion **52** is inserted into the receiving recess portion **27** of the movable housing **26** of the first connector **1**. As a result, the fitting block portion **52** is fitted into the movable housing **26** (refer to FIG. **1**(B) and FIG. **2**(B)).

When the second connector **2** is fitted into the first connector **1**, the contact portions **44** formed of the contact pieces **44**A with the finger shape tightly sandwich the contact portions **11**A of the first terminals **10** of the first connector **1**. Accordingly, the second terminals **40** of the second connector **2** elastically contact with the contact portions **11**A of the first terminals **10**.

As described above, the contact portions **44** of the second terminals **40** have the throat portions **44**A-**1** at the lower end of the contact portions **44**A. Accordingly, when the contact portions **11**A with the flat band shape of the first terminals **10** are smoothly inserted into the throat portion **44**A-**1**, the contact portions **44**A tightly sandwich the contact portions **11**A of the first terminals **10** with the elastic force, and the second terminals **40** are electrically connected to the first terminals **10**.

When the first connector **1** is connected to the second connector **2**, the electrical circuit board attached to the first connector **1** is electrically connected to the electrical circuit board attached to the second connector **2** through the first terminals **10** and the second terminals **40**.

As described above, the first terminals **10** of the first connector **1** have the elastic portions **14**. Accordingly, even when the second connector **2** is shifted from the standard position or the standard posture in the longitudinal direction, the lateral direction, or the pulling out direction of the second connector **2**, it is possible to absorb the shift through the elastic portions **14**. Further, even when the first connector **1** or the second connector **2** receives vibrations, it is possible to absorb the vibrations through the elastic portions **14**.

Further, in the embodiment, in addition to the elastic portions **14**, the contact portions **11**A of the first terminals **10** are formed in the flat band shape. Accordingly, when the contact portions **44** sandwich the contact portions **11**A, the throat portions **44**A-**1** are capable of sliding and shifting (moving) relative to the contact portions **11**A, even though friction is caused between the throat portions **44**A-**1** and the contact portions **11**A in the lateral direction and the pulling out direction of the first connector **1**. As a result, it is possible to absorb the shift or the vibrations through the contact portions **11**A.

More specifically, as described above, the first terminal **10** has the movable side held portion **11**B held with the movable housing **26** and the fixed side held portion **12**B held with the fixed housing **21**. Further, the elastic portion **14** is disposed between the movable side held portion **11**B and the fixed side held portion **12**B, and is connected to the movable side held portion **11**B and the fixed side held portion **12**B through the movable side transition portion **15** and the fixed side transition portion **16**, respectively.

Further, as described above, the elastic portion **14** is formed of the wave portions having the substantially M character shape and rising from the movable side transition portion **15** and the fixed side transition portion **16**. Accordingly, the elastic portion **14** is capable of elastically deforming in any of the connector height direction, the connector longitudinal direction, and the lateral direction (the connector width direction). As a result, even when the first connector **1** and the second connector **2** are shifted or receive the vibrations in any direction, it is possible to absorb the shift or the vibrations.

Further, in the embodiment, the straight portions **14**D, **14**E, **14**F, and **14**G form the widening width portions that are inclined such that the open width of the wave shape portions is increasing in the direction away from the bent portions **14**A, **14**C, and **14**B, respectively. The wave portions are formed in the U character shape at the center thereof, and the inverted U character shape at the both sides. Accordingly, even when the movable housing **26** and the fixed housing **21** pushes the elastic portions **14** in the connector width direction and the wave portions approach to each other, the wave portions tend not to contact with each other. As a result, it is possible to secure an amount of the elastic deformation of the elastic portions **14**.

In the embodiment, as described above, the elastic portion **14** has the straight portions **14**D, **14**E, **14**F, and **14**G inclined to form the widening width portions in the wave shape portions. It is suffice that at least the wave shape portions situated at the both outside sides adjacent to the movable side held portion **11**B and the fixed side held portion **12**B have the widening width portions. The wave shape portion situated at the center may not be inclined to form the widening width portion.

Further, in the embodiment, the straight portions **14**F and **14**G situated at the both outsides are connected to the movable side transition portion **15** and the fixed side transition portion **16** through the inclined portions **14**H and **14**I, respectively, which are inclined to get closer to each other at the lower position below the bent portion **14**B situated at the center of the elastic portion **14** in the connector width direction. Accordingly, there is no wave shape portion between the movable side transition portion **15** and the fixed side transition portion **16**. As a result, even when the elastic portion **14** is pushed and elastically shifted in the connector width direction, the movable side transition portion **15** and the fixed side transition portion **16** tend not to contact with each other.

Further, in the embodiment, the straight portions **14**D, **14**E, **14**F, and **14**G have the band width smaller than that of the bent portions **14**A, **14**B, and **14**C. Accordingly, the elastic portion **14** is capable of easily deforming with the bent portions **14**A, **14**B, and **14**C as a pivot. Further, when a length of the straight portions **14**D, **14**E, **14**F, and **14**G is increased within an allowable range, that is, a size of the wave portions is increased, it is possible to increase the amount of the elastic deformation of the elastic portion **14** in any of the connector height direction, the connector longitudinal direction (the direction perpendicular to the plate surface of the elastic portion **14**), and the lateral direction (the connector width direction).

Further, in the embodiment, the straight portions **14**D, **14**E, **14**F, and **14**G have the band width smaller than that of the bent portions **14**A, **14**B, and **14**C. Accordingly, when the elastic portion **14** is elastically deformed, it is possible to disperse a stress applied to the bent portions **14**A, **14**B, and **14**C to the straight portions **14**D, **14**E, **14**F, and **14**G. Accordingly, when the elastic portion **14** is elastically deformed, the bent portions **14**A, **14**B, and **14**C and the straight portions **14**D, **14**E, **14**F, and **14**G tend not to contact with each other.

Further, in the embodiment, the straight portions **14**D, **14**E, **14**F, and **14**G have the terminal width (the band width) gradually decreasing toward the central portions thereof. It is suffice that some of the straight portions **14**D, **14**E, **14**F, and **14**G or the bent portions **14**A, **14**B, and **14**C have the terminal width (the band width) gradually decreasing. The remaining ones of the straight portions **14**D, **14**E, **14**F, and **14**G or the bent portions **14**A, **14**B, and **14**C may not have the terminal width (the band width) gradually decreasing.

In the embodiment, the present invention is applied to the first connector **1** and the second connector **2** attached to the electrical circuit boards arranged in parallel. Alternatively, the present invention may be applied to a connector attached to the electrical circuit boards arranged perpendicularly, that is, a triangle connector.

The disclosure of Japanese Patent Applications No. 2015-244322, filed on Dec. 15, 2015 is incorporated in the application by reference.

While the present invention has been explained with reference to the specific embodiments of the present invention, the explanation is illustrative and the present invention is limited only by the appended claims.

What is claimed is:

1. An electrical connector for connecting an electrical circuit board and a mating connector, comprising:

a terminal having a connecting portion to be connected to the electrical circuit board and a contact portion to be contacted with the mating connector; and

a housing for holding the terminal,

wherein said housing includes a fixed housing to be attached to the electrical circuit board and a movable housing arranged to be movable relative to the fixed housing,

said terminal includes a fixed side held portion held with the fixed housing, a movable side held portion held with the movable housing, and an elastic portion situated between the fixed side held portion and the movable side held portion,

said housing includes an accommodating space situated between the fixed housing and the movable housing for accommodating the elastic portion,

said elastic portion includes at least a first wave shape portion and a second wave shape portion,

said first wave portion includes a first bent portion and a pair of first extending portions,

said first bent portion is situated above the first extending portions in a height direction of the elastic portion,

said second wave shape portion includes a second bent portion and a pair of second extending portions separated from the first extending portions,

said second bent portion is situated above the second extending portions in the height direction,

said elastic portion includes a third bent portion between the first wave shape portion and the second wave portion so that the elastic portion has an M character shape,

said terminal further includes a fixed side transition portion situated between the elastic portion and the fixed side held portion and a movable side transition portion situated between the elastic portion and the movable side held portion,

and

said fixed side transition portion and said movable side transition portion are situated completely below the third bent portion in the height direction.

2. The electrical connector according to claim **1**, wherein one of said first extending portions is situated between the first bent portion and the second bent portion.

3. The electrical connector according to claim **1**, wherein said bent portion has a first width, and

each of said first extending portions has a second width smaller than the first width.

4. The electrical connector according to claim **1**, wherein said elastic portion includes a first inclined portion extending downwardly from one of the first extending portions, and a second inclined portion extending downwardly from one of the second extending portions,

said first inclined portion is disposed between the first wave shape portion and the fixed side transition portion,

said second inclined portion is disposed between the second wave shape portion and the movable side transition portion, and

said first inclined portion and said second inclined portion are inclined inwardly.

5. The electrical connector according to claim **1**, wherein said first extending portions are configured to extend away from each other with a distance in between decreasing toward the first bent portion, and

said second extending portions are configured to extend away from each other with a distance in between decreasing toward the second bent portion.

* * * * *